Immature Stages of the Flesh Fly, *Parasarcophaga* (*Thomsonea*) *argyrostoma* (Robineau-Desvoidy)[1]

JULIAN R. YATES, III
UNIVERSITY OF HAWAII, HONOLULU, HAWAII

INTRODUCTION

Lopes (1961) lists 14 species in the family Sarcophagidae as occurring in Hawaii. *Parasarcophaga* Johnston and Tiegs (1922) was first proposed as a subgenus of *Sarcophaga*. It is now treated as a genus and has been split into a number of subgenera by the authorities on this family. According to Lopes (1958) *Parasarcophaga* is characterized by the following: "Penis with a long-stalked ventralia; abdominal tergite 6 (first genital) of female composed of two well-separated plates; tergite 7 of female vestigial; abdominal tergite VII of female bare or with a transverse row of strong bristles; sternite VIII membranous; anal membrane bearing delicate hairs have large pigmented bases." The species *argyrostoma* has been placed in the combination *Parasarcophaga* (*Thomsonea*) by Lopes (1958).

The species *Parasarcophaga argyrostoma* is worldwide in distribution including Europe, North America, Chile, Africa, India, Argentina, the Hawaiian Islands, and the Marshall Islands (Lopes, 1961). Other species of *Parasarcophaga* occurring in Hawaii are *Parasarcophaga* (*Jantia*) *ruficornis* (Fabricius), *Parasarcophaga* (*s. str.*) *albiceps* (Meigen), and *Parasarcophaga* (*Liosarcophaga*) *misera* (Walker).

Synonyms of *P. argyrostoma* include: *Myophora argyrostoma* Robineau-Desvoidy; *Sarcophaga argyrostoma* Seguy; *Sarcophaga barbata* Thomson; *Sarcophaga nurus* Rondani; *Sarcophaga falculata* Pandelle; *Sarcophaga argentina* Brethes; and *Sarcophaga georgina* Wiedemann (Lopes, 1961: p. 426).

Species of the family Sarcophagidae are predominantly larviporous in their method of reproduction. The hatching of eggs takes place in the uterus of the female just a short time before deposition occurs.

The gestation period of these larviporous species is fairly uniform, ranging from 10–16 days from the time of copulation. Following this, the larviposition period is relatively short, seldom exceeding 10 days. As compared to most other dipterous forms, the fecundity of these flies ranges anywhere from 80–300 larvae per female at 1 deposition (Clausen, 1940).

MATERIAL AND METHODS

P. argyrostoma, also larviporous, is largely carnivorous. It frequents decaying flesh matter, but will also breed in poultry droppings. Bohart

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and Gressitt (1951) found that carrion (including fish and shellfish) and human excrement were the most attractive to larvae and adults of 6 species of *Sarcophaga*. The flies for this study were reared, under laboratory conditions (temperature: 22–25 °C; relative humidity: approximately 60%), on bovine heart muscle. All fat was removed from the meat to prevent rancidity.

Larvae were obtained by placing a piece of this meat in a cage containing adults. This was done 10 days after approximately 50% of the flies had emerged. Both male and female adults fed on the meat and after a period ranging from 2–15 hours, larviposition was evident. The piece of meat was left in the cage for approximately 15 hours at which time it was removed and placed in a plastic container the open end of which was sealed with organdy material.

RESULTS

Life History.—A characteristic of these flies is the tiny white specks left at the site of deposition. These were examined and found to be membranous materials resembling the chorion of eggs. The presence of this material may be due to either of three things: (1) After the larvae were extruded from the female, they immediately emerged from this thin membranous material. If this should be proven the case, then these flies can hardly be termed true larviporous forms. (2) The material was extruded after each larva was deposited; or (3) the membraneous materials were deflated infertile eggs, for never has the number of white specks equalled the number of larvae deposited. However, in contradiction to this possibility, was the presence of rigid infertile eggs deposited on the media.

Freshly deposited larvae ranged from 2–3 mm in length and larval maturity was reached on about the 7th day. As for most muscoid larvae, this state is easily recognized by two factors. First is the clearing of the alimentary canal, mainly the crop region. When the larvae are in the active feeding stage this region is darkened by the food intake. The second fact is that when the larvae are ready to pupate they tend to leave the media and search for a suitable pupation site, preferably a dry area. To provide such a site 2 sheets of ordinary hand towel were placed under the petri dish containing the meat. On the 8th day the remains of the media were removed.

Pupation began on approximately the 8th day and lasted 12 days with adults emerging 20 days from the time of larval deposition.

The life-cycle, therefore, lasted approximately 3 weeks. On this basis and under similar environmental conditions, about 17–18 generations will be produced each year by this species. In temperate areas, where winters occur, fewer generations can be expected.

Larval Morphology.—Larvae of *P. argyrostoma* are membranous and delicate. They range in color from light yellow to near white and are typi-

Lateral View of Head End

Fig. 1. 1st Instar (40.5×)

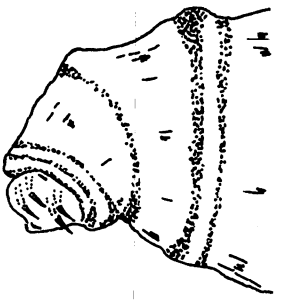

Fig. 2. 2*nd* Instar (27×)

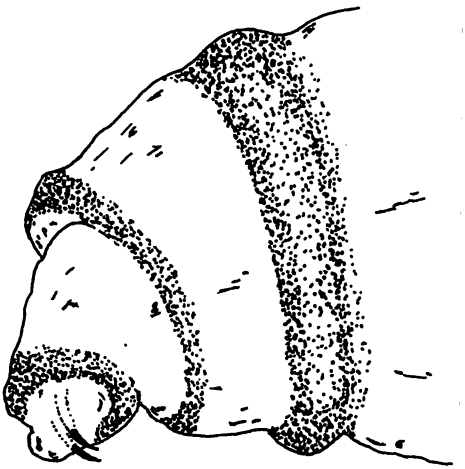

Fig. 3. 3*rd* Instar (10.5×)

Right Caudal Spiracle

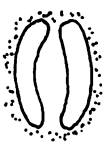

Fig. 4. 1*st* Instar (90×)

Fig. 5. 2*nd* Instar (45×)

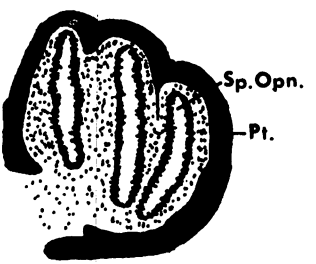

Fig. 6. 3*rd* Instar (27×)

cal muscidiforms in that their bodies taper from the posterior to anterior end (James, 1947).

The larvae emerge from females as living young and develop through 3 instars. The first instar persists for approximately 20 hours from the

time of deposition. The individuals are about 2–4 mm in length and possess two mouth hooks (1 pair, Fig. 1). There are no spiracles on the lateral aspects of the prothorax and two spiracular slits exist for each caudal spiracle surrounded by a very lightly sclerotized area (Fig. 4).

The second instar occurs from approximately 20–60 hours after deposition and is easily distinguished by the presence of 4 mouth hooks (2 pairs, Fig. 2). The anterior pair, however, may not be as clearly visible as the posterior pair, for in the majority of specimens the anterior pair appeared to be completely within the nonsclerotized head. Prothoracic spiracles (Fig. 11) are present on the lateral aspects of each side. Each caudal spiracle, again, has only 2 spiracular slits and is now surrounded by a definite sclerotized peritreme (Fig. 5) open at the ventromesal area and without a

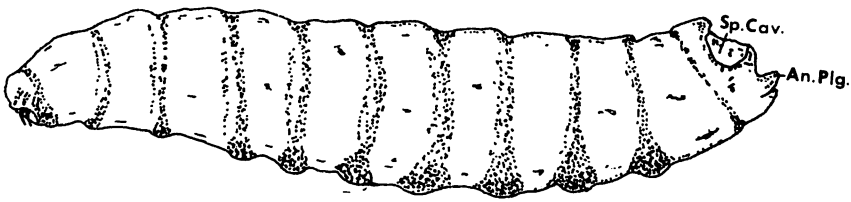

Fig. 7. Lateral View of Larvae (12.9×)

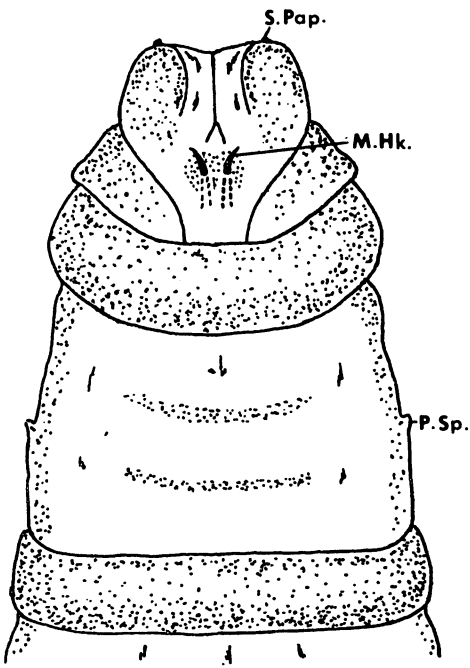

Fig. 8. Ventral View of Head End (45×)

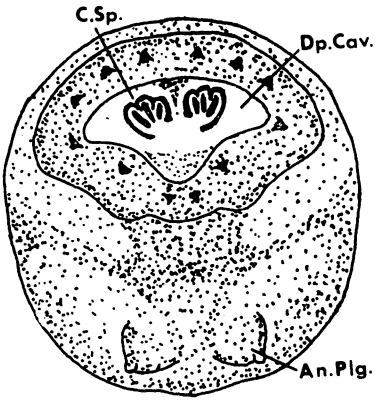

Fig. 9. Caudal View of Posterior (Larva) End (21×)

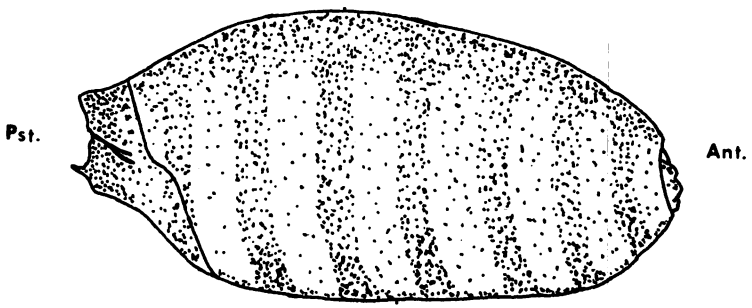

Fig. 10. Lateral View of Pupa (25.5×)

button. Larvae during this period range from 4–8 mm in length.

The 3rd instar occurs approximately 60–192 hours after larval deposition and ranges from 8–22 mm in length. Two mouth hooks (1 pair, Fig. 3) reappear as in the 1st instar and the prothoracic spiracles remain present. The most obvious morphological character is the presence of 3 somewhat parallel spiracular slits for each caudal spiracle (Fig. 6); the previous 2 instars possessed only 2 openings. The slit nearest the meson is shorter and more distant than the remaining 2. The discontinuous peritreme is more heavily sclerotized than that of the 2nd instar and its inner and outer margins invaginate dorsally between the slits.

The larvae possess a metapnuestic respiratory system when newly emerged (1st instar) and in subsequent instars (2nd and 3rd) develop an amphipnuestic system of respiration.

The morphological characters discussed herein will be based upon the 3rd instar since the larvae are essentially similar for each instar except for the differences mentioned above.

In lateral view (Fig. 7) the larvae are typically muscidiform and reach a length of 20–25 mm at maturity. Bands of spines occur on the

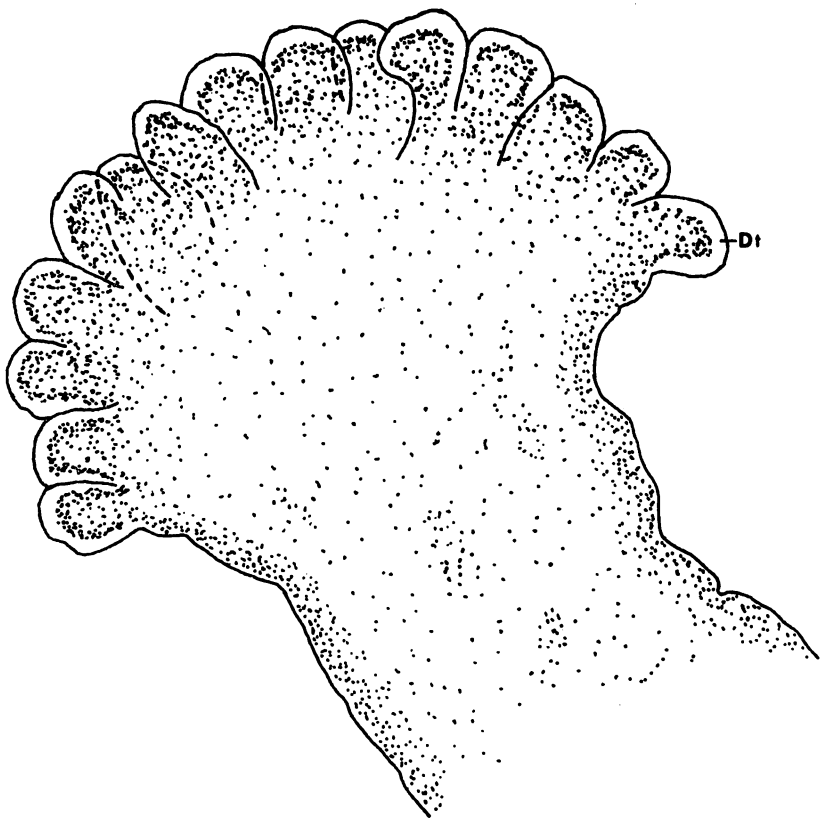

Fig. 11. Prothoracic Spiracle (400×)

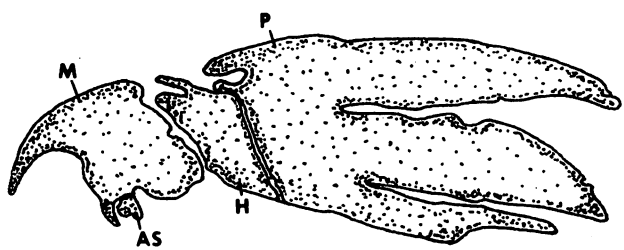

Fig. 12. Lateral View of Mouth Hooks (32×)

anterior margins of all body segments though those of the prothorax are not as conspicuous.

The head, retractible in the thoracic region (Fig. 3), is nonsclerotized as is the rest of the body. Two very reduced antennae, more often called sensory papillae (Peterson, 1960), occur on the cephalolateral rounded areas (Fig. 8). In ventral view (Fig. 8) inconspicuous lines radiate from the

mouth-opening in a caudal direction. These lines resemble pseudotrachae in the oral discs of the adults and most muscoid forms. Maxillae and other similar mouth parts are absent. The mouth hooks (Fig. 12), sometimes called mandibles, are paired, parallel, retractible, decurved, heavily sclerotized, and black in color. In operation they are sickle-like in that movement is in a verticle plane. As with most cyclorrhapha forms, there is a characteristic framework of articulated sclerites, the whole being known as the cephalopharyngeal skeleton (Imms, 1934). The structure is composed of the following principal sclerites: The mandibular sclerites (mouth hooks) are the most anterior, and articulate with the hypostomal sclerite which receives the opening of the salivary duct. A small, dentate sclerite unites the bases of the 2 mandibular sclerites. The pharyngeal sclerite, the most posterior and largest, is formed by 2 verticle lamellae united ventrally to form a trough in which the pharynx is located.

The thorax is 3-segmented and devoid of any legs or related appendages. The segments, like those of the abdomen, possess a band of microspines on and around the anterior edge. These are mainly used in locomotion since no pseudopods are present. On each side of the prothoracic segment a spiracle (Fig. 11) appears to originate between the prothoracic and mesothoracic segments. Each spiracle terminates in 15 digits.

The abdomen is cylindrical in shape and consists of 8 segments, each with bands of microspines. The 4th, 5th, and 6th segments are the largest. In lateral view (Fig. 7) the bands of microspines are wider on the ventral surface, probably to aid in locomotion. One to 2 very inconspicuous plicae occur on the dorsum of each segment.

The caudal spiracles are located within a deep cavity of the 8th abdominal segment and are visible only from a caudal view (Fig. 9). The elevated margin of this spiracular cavity possesses 12 distinct tubercles. Three are on each side of the dorsal half, while 2 occur on each side of the ventral half and are directly ventrad of the 2 most lateral dorsal tubercles. The remaining 2 are situated in a median depression of the ventral half. Two anal protuberances (prolegs) occur ventrad of the spiracular cavity, between the cavity and the anal opening. A certain definite pattern of microspines is visible on the caudal surface.

Pupal Morphology.—Pupae of *P. argyrostoma* are coarctate (Fig. 10) in that the exuviae of the 3rd instar persists and forms the hard puparium. The puparium is ovoid in shape, dark brown to maroon in color, and ranges from 10–13 mm in length. The bands of microspines are still visible, though compressed together due to the contraction of the larva upon pupation. Caudal spiracles remain visible within the spiracular cavity and a definite retraction of the head exists at the anterior end. A distinct suture in the caudal region runs diagnonally in a posterior to anterior direction from the dorsal to ventral surface. Pupation occurs

approximately 190–193 hours from the time of larval deposition and persists for about 290–300 hours.

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Abbreviations Used in Figures

An. Plg.—anal proleg (protuberance)
Ant.—anterior
AS—dentate sclerite
C. Sp.—caudal spiracle
Dp. Cav.—deep cavity
Dt—digit
H—hypostomal sclerite
M—mandibular sclerite
M. Hk.—mouth hook
P—pharyngeal sclerite
P. Sp.—prothoracic spiracle
Pst.—Posterior
Pt.—peritreme
S. Pap.—sensory papilla
Sp. Cav.—spiracular cavity
Sp. Opn.—spiracular opening